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COLOUR VISION.

An Introduction to the Study of Colour Vision.

By Dr. J. H. Parsons. Pp. viii+308. (Cambridge: At the University Press, 1915.) Price 12s. 6d. net.

THE whole subject of colour vision is admittedly very difficult, as the knowledge of it involves familiarity with the experimental results of a physical as well as of a physiological laboratory, with the minute anatomy of the retina, and with the latest results of psychological research. Hitherto, all that is known, and the various suppositions that have been made about the subject, could only be learnt by a prolonged search through innumerable scattered papers on physics, physiology, medicine, and psychology in various languages, chiefly English and German; so that it is with most cordial thanks to the author that this *résumé* of the subject in its present state is welcomed.

The book is divided into three parts: part i. (pp. 1-157) devoted to "The Chief Facts of Normal Colour Vision"; part ii. (pp. 158-192), "The Chief Facts of Colour Blindness"; and part iii. "The Chief Theories of Colour Vision." The arrangement is admirable, the facts are well described with very few omissions, and no one after reading the first 191 pages will be surprised that so far no theory has been suggested that will account for all the facts. Perhaps a few of the difficulties of the subject may be indicated.

A given colour may be determined as is well known by its hue, its luminosity, and by its degree of saturation. It is not always remembered that:—

"Great increase of intensity of light not only alters its hue, but also alters its saturation, so that eventually it produces only the sensation of white light. It would seem, therefore, that luminosity is in some recondite sense an inherent 'whiteness' in the colour itself, differing in degrees in different spectral colours and varying with the intensity of these colours. Clearly we are here at the outset face to face with a *physiological* fact of immense importance, and much of the difficulty of colour vision is connected with this fact" (p. 29).

There is the obvious difficulty in comparing the luminosity of two different coloured lights, arising from the fact that they give rise to two different impressions, and we are surprised to find that, according to the note in the preface, there is no discrepancy when the luminosity is measured by the equality of brightness method or by the flicker

photometer. The curious coloured phenomena of rapid, intermittent stimulation of the retina (*e.g.* Benham's top) lead us to expect that there would be a marked discrepancy. However, the author's statements are fully borne out by Ives's results with the flicker photometer.

On p. 3 a sentence that refers to the diffraction spectrum has missed correction when the proofs were read:—

"It suffers, however, from the disadvantage that the spectrum is less bright and less extended than the prismatic spectrum, and from the still greater objection that the interference spectrum is never free from scattered light."

Surely the extent of the spectrum depends entirely upon the fineness of the grating, and its brightness may be increased by increasing the size of the grating; and if by the term "interference spectrum" is meant a diffraction spectrum, any impurity in it is due to the faultiness of the grating.

We are glad to notice Mr. Parsons's criticism of v. Helmholtz's spectro-photometer and similar instruments in which the intensity of light is reduced by means of Nicol prisms; much of the German work on the subject is inaccurate owing to the polarising methods used.

With regard to Weber's law, the important point mentioned on p. 20 that "it does not hold good for very low or very high intensities of stimuli" is to be borne in mind. Fechner's law is true within the limits that Weber's law holds. Schirmer found that it was true between 1 and 1000 candle-power illuminations (*i.e.* the function is continuous between these limits), but that at first his minimum difference was $\frac{1}{128}$, while after eight days' practice he could recognise a change of $\frac{1}{217}$ or even less (see *Ophth. Rev.*, vol. x., p. 179). Possibly the failure of the law at the lower limit might be explained by Fechner's later addition of a term s_0 to represent the "intrinsic light of the retina." If E denote the sensation, and S the stimulus, Fechner's law then takes the form

$$E = C \log(S + s_0) + C'$$

where C and C' are constants. Mr. Parsons makes no reference to this suggested emendation. The failure of the law at the upper limit may be due to changes in the mechanism verging on the pathological. The variation of the minimum distinguishable difference not only in each individual, but also according to his practice (as in the case of Schirmer), necessitates great precautions being used in the application of Fechner's law.

When the eye has been kept in the dark for

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twenty minutes or so, the condition of scotopia or twilight vision is developed, in which the retinal sensibility is enormously increased; it will now be found that if the illumination be very low the eye is absolutely colour blind. The curve of luminosity in such an achromatic scotopic eye is practically identical with the luminosity curve of the spectrum in any colour-blind person (p. 53), the brightest part of the spectrum being near the E line ($530\text{ }\mu\mu$) instead of near the D line ($580\text{ }\mu\mu$) as in the normal eye.

The phenomena of simultaneous and successive contrast and fatigue are dealt with in pp. 100-129, and then there follows an interesting account of the researches on the discrimination of colour by various animals and by primitive races. Conclusions about both of these must necessarily be indefinite. With regard to the latter, the mural decorations of ancient Egypt show that the sense of colour for red, yellow, green, and blue was well developed five or six thousand years ago.

Limits of space forbid a review of Part iii. on the various theories of colour vision: the duplicity theory—that the cones are the seat of impulses that lead to colour perception, while the rods are only influenced by light stimuli; the three components theory (Young, Helmholtz); the three opponents theory (Hering); and seven other theories are described and criticised with justice and judgment. The author is to be congratulated on producing a work that contains an immense amount of information with a good bibliography on the subject. He has given us an excellent general and unbiassed view of the facts and theories of colour vision.

THE EXPERIMENTAL METHOD IN MEDICINE AND SURGERY.

Animal Experimentation and Medical Progress.

By Prof. W. W. Keen. With an introduction by Dr. Charles W. Eliot. Pp. xxvi+312. (Boston and New York: Houghton Mifflin Company, 1914.) Price 7s. 6d. net.

IN America there are very few surgeons more eminent, more beneficent, or more widely beloved than Prof. Keen. He fulfils and represents the very highest traditions of American surgery. He has done great things in practice, and in teaching, and in writing; and his name is held in reverence by doctors and surgeons over here. So, when he writes a book for general reading on a medical subject, the general reader had better read it: especially as it has an introduction from Dr. Charles W. Eliot, sometime president of Harvard University. Besides, the book is admirably written, full of learning, full

of sympathy, full of a thousand facts touching man's daily welfare.

It is a justification, and more than justification, of experiments on animals for the advancement of the science and art of medicine and surgery. Prof. Keen is one of those leaders of his profession who are very sensitive to the brutal abuse and false witness of the "anti-vivisectionists." Whether it is wise to care so much what they say, each man must settle for himself. Anyhow, Prof. Keen does care very much indeed. He takes it to heart that these wild people are set to insult the medical profession, to give the lie to plain facts, and to attack with virulent language the very methods which they themselves take advantage of when they are ill. These people seem to be just as unkind and untruthful in America as they are here. Indeed, we are having a rest from them here, since the war began; except that some of them are trying to stop our soldiers from being protected against typhoid fever. It will be a grand thing, after the war, if we can keep anti-vivisection down, and give ourselves to worthier pursuits.

The book is a collection of essays, from 1885 to 1913, on the debt which mankind and the animal world owe to experiments on animals; and on the character and the attitude of anti-vivisection. The essays are complete, final, authoritative; they are the work of a master of surgery, a leader among surgeons. Where all are good it is hard to prefer one before another. Among those essays which review the benefits gained from experiments on animals, nothing could be better than "Recent Progress in Surgery," "Vivisection and Brain-Surgery," and "What Vivisection has done for Humanity." Among those essays which review the moral obliquity of anti-vivisection, nothing could be better than "The Influence of Anti-vivisection on Character," and "The Anti-vivisection Exhibition in Philadelphia in 1914." These two essays are masterpieces; they are gentle, quiet, courteous; but they expose a state of mind, in some American women, which is not pleasant to contemplate. Things were bad enough here, up to last August; but they seem even worse in New York.

Indeed, that is one of the strongest arguments against anti-vivisection—that it tends, unless it be held under self-control, to such amazing dishonesty, such greedy willingness to believe evil of other men, such loss of the sense of responsibility and of restraint.

But these faults, after all, are not the main theme of the book: and the work of nailing lies to counters is less important to us than the work of setting forth the great discoveries of medical and